IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Proteins and nanoscale surfaces- is there synergy?**	
Project Number	**IMURA0955**	
MonashMainSupervisor (Name, Email, Phone)	Prof Murali Sastry (murali.sastry@monash.edu)	*Full name,Email*
Monash Co-supervisor(s) (Name, Email, Phone)	Prof Santosh Panjikar (santosh.panjikar@synchrotron.org.au)	
Monash Head of Dept/Centre(Name,Email)	Prof Neil Cameron (neil.cameron@monash.edu)	*Full name, email*
Monash Department:	Materials Science and Engineering	
Monash ADGR (Name,Email)	Prof Timothy Scott (timothy.scott@monash.edu)	*Full name, email*
IITB Main Supervisor (Name, Email, Phone)	Prof Jayesh Bellare (jb@iitb.ac.in)	*Full name,Email*
IITB Co-supervisor(s) (Name, Email, Phone)		*Full name,Email*
IITB Head of Dept (Name, Email, Phone)	Prof Madhu Vinjamur (head.che@iitb.ac.in)	*Full name, email*
IITB Department:	Chemical Engineering	

Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address?
*(Please nominate JUST **one**. For more information, see www.iitbmonash.org)*

1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address?
(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1	*Advanced computational engineering, simulation and manufacture*
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	*Nanotechnology*
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*
8	Design

The research problem

Define the problem

The interaction of biologicals such as peptides, proteins and DNA with inorganic nanoparticles is fertile ground for research and has been motivated by the need to create biocompatible surfaces for surgical implants, design of 'smart' materials and templating action, to name a few. The size compatibility between nanoparticles and proteins, in particular, has resulted in much interest in designing and understanding nanobiomaterials.

Just how proteins interact with inorganic nanomaterials such as metals, oxides and quantum dots requires further study and elucidation. Often, proteins are thiolated to enable covalent binding with gold and silver nanoparticles. The interactions are different for oxides and quantum dots such as CdS. Some studies have used non-specific electrostatic interactions and other weak interactions to bind proteins to nanoparticles. Such approaches tend to disturb the structure of proteins and in turn, influence their biological activity.

Enzymes, a sub-class of proteins, are interesting from an application perspective in many industrial processes. Enzymes immobilised on nanoscale surfaces have been studied and it is often observed that the dynamic range of biological activity of the enzymes such as temperature, pH etc. is increased. Further, such nanobio materials can be reused reducing their cost in industrial applications. Another intriguing observation is that enzymes bound to nanoparticles often exhibit increased specific activity and while there are hypotheses to explain this, a definitive study on this yet to be done.

In this research topic, an in-depth study of protein-nanoparticle surfaces will be carried out using a variety of tools such as electron microscopy, photoemission spectroscopy, SAXS, X-ray crystallography, synchrotron radiation etc. A fundamental understanding of interaction of proteins and enzymes with nanoparticles will then be used to address the issue of synergy between proteins and nanoparticles.

Project aims

Define the aims of the project

1. Understand the interaction of unmodified and modified proteins with metal, oxide and quantum dot nanoparticles using a host of techniques including TEM, surface spectroscopies, vibrational spectroscopies and synchrotron radiation.
2. Design industrially relevant enzyme-nanoparticle hybrid materials and measure their biological activity and reuse profile.
3. Use better understanding of fundamental interactions between enzymes and nanoparticles to shed light on any synergistic action in the hybrids.

Expected outcomes

Highlight the expected outcomes of the project

1. A better understanding of fundamental interaction between proteins and a range of inorganic nanoparticles.
2. Design of industrially relevant enzyme-nanoparticle hybrid materials and measurement of their characteristics.
3. The results will be published in peer reviewed journals and patented, where appropriate.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

This project is at the interface between materials science and engineering and biotechnology. It therefore falls within two themes of the Academy viz. Biotechnology and Nanotechnology.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

Students with the following background and interest in interdisciplinary research are encouraged to apply :

1. Postgraduate degrees in Materials Science and Engineering, Chemical Engineering. In exceptional cases, students with bachelors degree in these disciplines may be considered.
2. Postgraduate degrees in Physics and Chemistry.
3. Postgraduate degree in Biotechnology. Interest and ability to do both bench experiments and mathematical modelling.

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.